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IN TWO SECTIONS

Section I

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IN THIS ISSUE

A Technique of Industrial Control,
by Robert W. Peden 851

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EDITORIAL DEPARTMENT NOTE

Case studies are always interesting and instructive because they show how the other fellow has applied basic principles to his particular conditions. Many such case studies have appeared in the Bulletin. In this issue we are presenting another, this time describing how standard costs are used by the Bundy Tubing Company of Detroit, to control manufacturing costs. The author's description of the method used, together with his enumeration of the important and unique features of the system and his arguments for standard cost accounting will be found most interesting.

The author of this article is Robert W. Peden who is known to N. A. C. A. members for his previous contributions to the Bulletins and his addresses at National Conventions. Mr. Peden is a native of Canada but has lived practically all of his life in the United States, and for a number of years has been interested in industrial cost work. He has an A. B. degree from Hiram College, Hiram, Ohio, and an A. M. degree from Columbia University. For a number of years he was Controller and Treasurer of Mueller Brass Company, Port Huron, Michigan, and for the last two years he has been employed by the Bundy Tubing Company, Detroit, where he has been particularly responsible for the development of their system of standards and cost control.

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APRIL 1, 1937

TECHNIQUE OF INDUSTRIAL CONTROL

By Robert W. Peden, Cost Accountant
Bundy Tubing Co., Detroit, Mich.

DURING the period from 1930 to 1934 our country passed through a memorable economic and financial crisis. All real estate values, both urban and rural, declined precipitously and practically all commodity prices fell to levels at or below the actual cost of production. Millions of industrial workers were unemployed and we experienced a demoralization of our agricultural life never before equalled in the nation's history. Vast railroad consolidations, time-honored brokerage houses, and established manufacturing corporations became entangled in reorganization or receivership proceedings. Great metropolitan cities and other governmental units defaulted in the payment of their bonds and were unable to pay school teachers' salaries. (A "far-famed" and a "far-flung" public utility "empire" crashed in ignominious ruin, and finally, early in 1933, the entire commercial banking system collapsed, with disastrous results to millions of stockholders and depositors alike.

During those never-to-be-forgotten years, there was one type of economic enterprise which remained sound and solvent amid the general ruin and despair,—a type of business institution which seemed able to withstand successfully all the periodic shocks of a world depression without defaulting in the payment of its liabilities and without materially modifying its contracts,—a type of business which was able to lend money when all others were frantically seeking to borrow,—a type of business which maintained an excess of revenue over expenses when nearly all others showed heavy losses from their operations and an insolvent condition for their financial structures. I refer, of course, to those institutions known as the great "legal reserve" life insurance companies of the United States.

Many superficial explanations have been given for this well-known record. It has been said that the life insurance companies passed through the crisis successfully because they had invested their funds in bonds rather than in common stocks, and that their rates have always been regulated by law. Such explanations are fallacious because the depression was as disastrous to bondholders

as to stockholders. Our great banks, railroads, and public utilities had been much more closely supervised as to their charges than the life insurance companies, and yet many of them failed, ceased operations, or were forced to recapitalize and reorganize entirely.

The real causes are much more fundamental and far reaching. Like most economic forces the success of the life insurance companies was a composite result of a number of very important and thoroughly tested policies. In the first place, the life insurance business has been controlled from the beginning by *actuarial* or *statistical science* rather than by the economics of supply and demand, competition, or guesswork. I would define statistical science as that technique which has been developed by mathematicians for the classification, analysis, and interpretation of vast aggregations of numbers, particularly by such devices as percentages, ratios, averages, medians, modes, index numbers, graphic charting, and correlations. The mortality table adopted many years ago is based on records of births and deaths extending back for three hundred years to the original records in Breslau, Germany. As such it is loaded to allow for such great emergencies as depressions, epidemics, floods, fires, and wars. A second reason is that the rate structures employed by the life insurance companies are so detailed that every class of risk is assumed to be self-sustaining. There has never been any practice of permitting the profitable sales to carry the unprofitable. Rates by age, by sex, by race, by occupation, and even by moral rating, assure the companies a sound relationship for each sales classification. A third reason is that all mortality and interest tables have been free from the confusing influence of a fluctuating dollar valuation. A fourth reason, however, and the most important in my opinion, is that the life insurance companies employ what is in reality a uniform or *standard* cost accounting system, because all of them use the same mortality table, the same interest tables, and their own budget schedules of operating expenses. All variances between the actual and the expected mortality, the actual and the calculated interest incomes, and the actual and the budgeted operating expenses are not only published but exchanged annually by the associated companies for their common information and guidance.

I have made this seemingly irrelevant reference to the life insurance business partly because many industrial accountants are not

convinced of the merits of standard cost accounting methods, partly because the stability of the life insurance companies proves the efficacy of these methods, and partly because at the Bundy Tubing Company we have tried to develop a system of control through standards which will give our company something of the qualities of stability and permanence characteristic of the life insurance business.

Our company manufactures specially welded steel tubes, up to 5/8" in diameter, principally for automobile brakes, gas, and oil lines, but also for electrical refrigerators, radios and other modern devices. Practically all of these tubes are sold in finished, fabricated form; that is, bent, flared, and equipped with the necessary fittings so that they may be quickly dropped into the chassis on the assembly lines. The company is therefore, essentially in the jobbing business, manufacturing most parts from the customers' prints and according to separate estimates and prices. There are about 1,100 employees and the manufacturing processes fall into two logical divisions; first, the manufacture of the tubes by expensive machine processes; second, the fabrication of the tubes, which is largely done by manual methods. The principal forms of wage payment are piece work and day work.

In the exposition of our methods, which follows, I would like to discuss the measurement and control of five different phases of our business:

1. Material costs and material utilization
2. Machine operating costs
3. Labor costs
4. Manufacturing burden
5. Prices and profits.

All figures shown in the illustrations are not actual but illustrative only and are offered by courtesy of the management which has always believed in supporting such constructive organizations as the National Association of Cost Accountants.

1. *The Measurement and Control of Material Costs*

The raw material from which our tubing is made consists of copper coated steel strip, wrapped into conveniently sized coils.

As the copper coating must be held to close tolerances, the cost per pound is higher than for ordinary steel strip. Furthermore, the element of material cost is higher in relationship to labor and burden costs than is the case with most manufacturing corporations. Accordingly any wastage or spoilage of these materials is most serious both because of the higher initial cost and also because of the relatively low salvage value of steel scrap when it is mixed with copper.

At the beginning of each year a standard cost per pound is determined for each separate size of strip. As the material is received into the plant the weights on the invoices are extended at these standard figures and the differences are charged or credited to a raw material purchase variance account, supported in detail by separate accounts for each specific size. As a result, it is possible to use throughout the year in all cost accounting and inventory pricing these constant figures; and the size of the variances, whether debits or credits, becomes not only a measure of efficiency in purchasing but also a signal for the detection of any unusual trend in purchase prices. The raw material inventory accounts, therefore, are kept in actual quantities at *standard* unit costs per pound. When the strip is released from raw material stock to the work-in-process accounts the *actual* quantities used are extended at the standard prices and compared, through the medium of monthly manufacturing cost summaries, with the *standard quantities* extended at the *standard prices*. We thus have a second group of material variance accounts by sizes of tubes, these latter accounts being called "Material Utilization" variance accounts, because they are affected only by the following three cost factors:

1. Variances in material wastage
2. Variances in the quantities spoiled in processing.
3. Variances in the elongation as the strip is made into tubes.

If the scrap and spoilage are high in any month these variance accounts will have debit balances, as would be the case if the actual scrap were 7% compared to a standard cost allowance of 3%.

To summarize, the figures in the purchase variance accounts and their ratio to the standard cost of sales are a measure of the trend of prices and the efficiency of purchasing; and the figures in the material utilization variance accounts become a measure of the

performance of the tube manufacturing divisions in controlling waste and spoilage.

As the foregoing accounting arrangement is on a *monthly* basis for accounting purposes only, and as spoilage occurs in tube fabrication as well as in tube manufacture, we have supplemented these variances with two additional sets of reports, which we believe have been exceedingly valuable in controlling these material costs. Both of these are compiled from the daily scrap tickets which are made out as the scrap is collected. Each batch of scrap is carefully ticketed with the following information: (1) the originating department number, (2) the department number held responsible, and (3) the proper cause, for classification as spoilage or waste material.

The first of these reports is a monthly statement of the cost of the scrap by originating departments. The cost is calculated by adding to the raw material cost the total labor and standard manufacturing burden up to and including the department where the loss is incurred.

The second report is a monthly analysis of the scrap by departments held responsible and by a classification of causes under two captions—natural waste, and spoilage. We define natural waste as the portion of the raw material which cannot be fully utilized, such as: bands, inspection endage, and short ends from the saws. We classify spoilage as the loss of the product because of imperfect manufacturing, either because of machine troubles or faulty workmanship. We furnish every foreman a daily statement showing his monthly cumulative scrap ratio, which is the relationship between the scrap for which his department is held responsible and the total materials delivered to him for manufacture.

The importance and efficacy of these reports may be understood from the fact that in 1935 our scrap cost $176,000, based upon a yield of 90%, or a total scrap loss, including wastage and spoilage of 10%. In 1936 this has been reduced from 10% to 8.87%, and is down to 7.50% at the present time, chiefly due to a better control of spoilage. A stimulating effect of these figures has been to direct the energies of our production and technical staffs to the importance of reducing scrap through im-

proved metallurgical control, better stock, and a closer check of machine wearing parts.

2. The Measurement and Control of Machine Operating Costs

In the Bundy Tubing Company plant, as in thousands of others, the basic operations are carried out by very speceial machine units with a relatively high initial cost and a correspondingly high operating cost. Accordingly, the task of utilizing these units to secure the maximum possible production is a technical and administrative problem calling for accurate cost control.

To secure this control we have evolved a system based on the premise that these costs are essentially our expression of the relationship between time on the one hand and the quantity of productive units on the other hand. We have, therefore, adopted the standard machine or process hour as the vehicle for charging costs into the work-in-process accounts. The unit of production is the foot of tubing produced.

Our chart of accounts subdivides these tube manufacturing processes into six burden centers, each with its own rate. All operating cost factors, except the steel strip, are charged to the code numbers for these burden centers. This includes all labor such as foremen's salaries and operating wages; all repair and maintenance costs, including both labor and materials; all tools, power costs, and processing supplies such as electricity, gas, oils, solders, fluxes, and machine wearing parts; and all fixed and apportioned charges. In other words, the process cost rates or machine burden rates are designed to absorb all manufacturing costs except the raw materials. We believe that there is no necessity for separating direct operating labor from other labor as all have a very direct and close relationship to the operating time of the process.

The method of developing the standard times is illustrated by Exhibit 1. We first determine by an engineering analysis the exact time of the machine itself, with *no* allowances for intervals between units, setup time, repair time, or other contingencies. We next plot the existing rate of production from performance records. Then, by a system of allowances, first for such necessary delays as intervals between units, setup time, maintenance, down time, etc., and secondly, for personal delays such as fatigue, etc.,

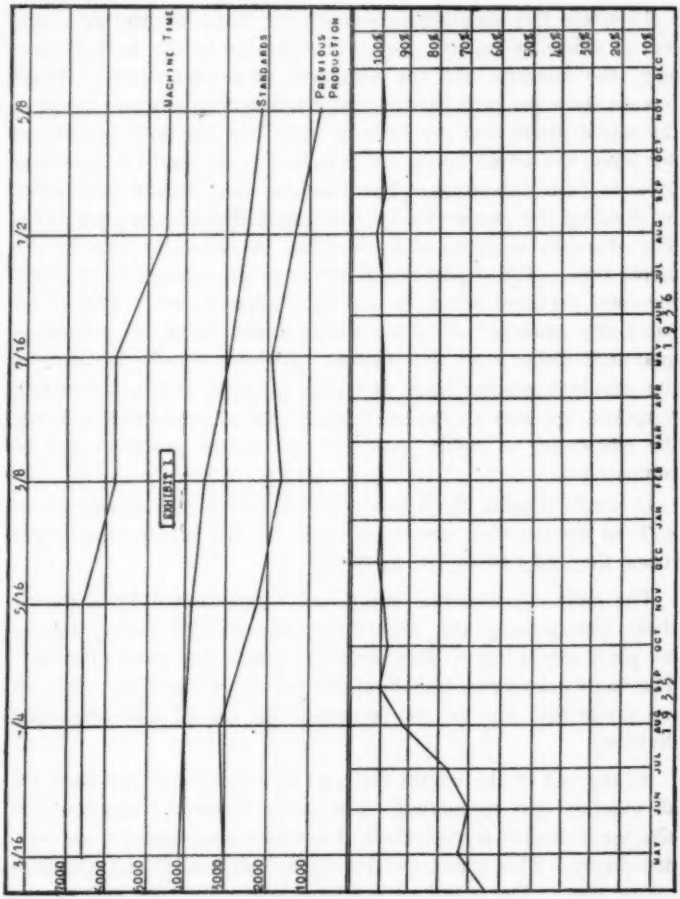
EXHIBIT 1
Machine Time
Standards
Previous Production
3/16
1/4
5/16
3/8
7/16
1/2
5/8
7000
6000
5000
4000
3000
2000
1000
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%

we arrive at a numerical expression of production which we reason is attainable if management and labor cooperate. In the chart shown these allowances vary according to the sizes of tubes.

To attain this standard production per hour we employ a system of efficiency reports, copies of which go to the factory manager, the foremen, and the standards department daily. These reports show for each burden center the total production by sizes, the actual production per hour by sizes, the standard production per hour, the actual hours, the standard hours, and the efficiency by sizes (see Exhibit 2). The standard time allowed is obtained by dividing the production by the standard production per hour. The efficiency is obtained by dividing the standard time by the actual time. The departmental efficiency is obtained by dividing the total standard hours by the total actual hours. This eliminates any mathematical error which might result by comparing quantities rather than time factors. In other words, we have in the standard process hour, not only a useful factor for costing purposes, but also a common denominator of production whereby the efficiencies of unlike products and unlike processes can be compared.

In actual practice these production standards are usually about 80% of the machine speeds, although for the heavier and larger tubes, they may be as low as 65%.

The daily departmental sheets are supplemented by a similar sheet summarizing the department figures and giving figures for plant actual hours, plant standard hours, and plant efficiency. The factory manager, therefore, can see clearly each day what his net production was for the preceding day for *all* tube producing divisions.

At the end of the month the total figures become the basis for all monthly cost accounting. The *actual* machine hours for each size are extended at the standard machine hour rate for the burden center. This product is known as our *actual* tube manufacturing cost. The standard machine hours are extended at the standard departmental burden rate. The difference is called the tube manufacturing variance account, and the size of the figures reflects the gain or loss due to the success or failure of the plant in attaining the production standards.

EXHIBIT 2

DAILY DEPARTMENTAL OPERATING REPORT

Department Name: Tube Tinning
Standard Burden Rate

Dept. No. 14
Date: Nov. 12, 1936

Size of Tubing	This Date Only						Month to Date				
	Production			Time			Production		Time		
	Total Prod.	Act. Ft./Hr.	Std. Ft./Hr.	Act. Hours	Std. Hours	Eff.	Total Prod.	Act. Ft./Hr.	Act. Hours	Std. Hours	Eff.
3/16—022.....	32,223	4,028	4,100	8.0	7.86	98.2	248,546	4,142	60.0	60.7	101.2
1/4 —028.....	65,112	4,069	4,000	16.0	16.27	101.7	660,820	3,993	165.5	165.2	99.8
5/16—028.....	11,557	3,852	3,900	3.0	2.96	98.7	366,067	3,940	92.9	93.7	100.9
3/8 —028.....	1,465	2,930	3,500	.5	.42	84.0	245,220	3,601	68.1	70.1	102.9
7/16—032.....	5,887	2,944	3,000	2.0	1.96	98.0	134,606	3,175	42.4	44.9	105.9
1/2 —035.....	5,210	2,605	2,600	2.0	2.00	100.0	83,393	2,598	32.1	32.1	100.0
5/8 —035.....	1,052	2,104	2,200	.5	.48	96.0	5,511	2,204	2.5	2.5	100.0
Totals	122,506	.....	.....	32.0	31.95	99.8	1,744,163	.....	463.5	469.2	101.2

REMARKS:
(These figures are not actual, but illustrative only)

There is one exception to this practice which should be noted; namely, the case of a size or class of tube, the production of which has caused consistent trouble due either to its newness or the fact that production can be obtained in limited quantities only. For example: the production standard for a particular size may be 2,000 feet per hour but because of persistent trouble actual production for months has been at the rate of 1,100 per hour. In such a case the standard used for cost accounting, or rather the rate of production which is used for incorporation into the standard cost will be 1,100 feet per hour, even though 2,000 may still be reflected on the production report for control purposes. The object of this exception is to prevent the sale of a class of product at an unprofitable price until the product has passed from the "experimental" into the "production" category.

The effectiveness of these reports in raising machine performance is attested by the fact that the monthly figures for departmental efficiency have shown the following increases in the two year period from January 1935 to December 1936:

Bundyweld machines	28.0%
Bundyweld furnaces	45.0%
Sweated machines	39.0%
Draw Benches	46.0%
Tinning machines	32.0%

Some of this gain has been due to mechanical improvements in the processes but a large part has been due to the steady elimination of down time because of trouble, an improvement in the raw materials used, and better scheduling.

3. The Measurement and Control of Labor Costs

For accounting purposes all the departments in our plant are divided into three logical groups, as follows:

1. Machine process departments operating on a time or day-work basis.
2. Fabricating departments operating on a piece-work basis.
3. Service or functional departments operating on a time or day-work basis.

As all piece-work rates are set from time studies we conceive our control problem to be one of assuring ourselves that all day-

EXHIBIT 3

DAILY DEPARTMENTAL LABOR REPORT

Dept. No. 14 Nov. 30, 1936

		EXPENSES						STANDARDS			
		This Date Only		This Month to Date				Rate		Totals	
		Actual	Std.	Actual	Std.	Over	Under	$	Per	Today	To Date
1402	Setup	....	.14	.....	3.46	....	3.46	.003	Mach. Hr.	48.0	1154.8
1403	Operating	40.20	38.40	915.49	923.84	....	8.35	.800	"	...	.....
1404	Idle Time	....	.00	.....	.....	....	....	.000		...	.....
1408	Servicing	....	.05	12.76	1.15	11.61	....	.001	"	...	.....
1420	Miscellaneous	....	.10	.....	2.31	....	2.31	.002	"	...	.....
	Totals	40.20	38.69	928.25	930.76	....	2.51	....		...	.....

(These figures are not actual, but illustrative only)

work costs are in accordance with production requirements. To accomplish this we operate a flexible labor budget plan, illustrated by Exhibit 3. These reports are issued daily in triplicate, one copy going to the foreman of the department affected, a second going to the superintendent, and a third remaining in the standards department.

For the machine processing departments the standard allowances are based on the standard machine hours. For example, in one department we have two machines placed in a parallel position each requiring its own operator. The time analysis indicates that there is a lowering of machine hour efficiency if these men are required to bundle and rack their own tubes. Accordingly we have assigned a helper to assist the two operators so that we have as a standard condition of production two machine hours and three man hours. Assuming that the operators receive 70¢ per hour and the helper 60¢, we have a labor allowance per machine hour of $1, or the operator's full rate, plus one-half of the helper's rate. When both machines run for a full shift, the standard allowances and the actual wages practically coincide, but if it is necessary to operate only one machine with a helper there will be an excess cost of 30¢ for each machine hour.

In the fabrication departments we have used as the basis for our allowances the dollar of direct labor cost. The controllable indirect labor is principally setting-up and trucking. To determine the proper allowance for this labor we have relied partly on time studies, partly on records of past performances, and partly on sound judgment. When the allowances are established they are not changed except at the end of each year. If a standard for setting-up labor cost is based on one set-up man serving twenty operators and production falls off to the point where there are only fifteen direct operators, twenty-five per cent of the set-up labor will be reflected as an excess cost.

On the contrary, if a foreman, through careful planning, is able to manage his department at less than his standard allowance we reflect the gain as a credit for each account throughout the year, the accumulation being an honest representation of the economy that he has earned for the company through good supervision.

A difficult problem with us is the control of inspection costs. As our management insists on every tube leaving the plant being

thoroughly tested and inspected, and as we believe that the quality of our product might be impaired if we employed piece work or any other form of incentive for the payment of inspection labor, we have continued to pay all inspectors on a time or day-work basis. However, we have supplemented this by a system of standards so that we are able to tell the chief inspector daily what his actual costs are, compared with his standards. This has been done by our plan of classifying the inspection work and computing a standard labor cost for each class.

For other service departments we have based our labor allowances not on the total direct labor for the entire plant, but rather on specific phases of production. Shipping labor is based on the tons of steel tubing shipped. Salvage labor is based upon the pounds of scrap sorted and baled. Scale clerks' labor is based on the direct labor in the saw department. Furthermore, practically all of this service labor is charted and budgeted, so that it is not strictly on a "straight-line" basis as is the case with the machine processing and fabrication departments.

EXHIBIT 4

DAILY INDIRECT LABOR SUMMARY

Nov. 30, 1936

Department	This Date Only		This Month to Date			
	Actual	Standard	Actual	Standard	Over	Under
9—Elec. Resis. Welder....	11.43	11.25	281.39	277.27	4.12	.....
10—Bundyweld Tube Mach..	107.26	110.88	2,666.45	2,574.20	92.25	.....
11—Bundyweld Furnaces ..	57.93	102.24	2,005.60	2,570.59	....	564.99
11A—Bundyweld Inspection.	101.80	101.95	2,515.06	2,499.52	15.54	.....
12—Sweated Tube Machines.	33.27	35.97	504.45	543.18	....	38.73
13—Draw Bench	36.86	37.90	678.99	708.90	....	29.91
14—Tinning Machines	29.30	30.06	893.19	883.13	10.06	.....
15—Sawing	40.93	31.67	744.73	679.82	64.91	.....
16—Burring	49.21	75.72	1,274.21	1,130.66	143.55	.....
17—Bundyweld Fabrication..	79.92	111.06	1,771.66	2,137.69	....	366.03
18—Tool Room	8.30	5.64	175.25	131.66	43.59	.....
19—Sweated Fabrication ...	10.88	10.10	165.52	189.09	....	23.57
26—Sweated Inspection ...	77.83	81.65	1,371.40	1,631.37	....	259.97
27—Stock Room	18.08	24.70	383.91	469.24	....	85.33
28—B. W. Testing and Insp.	588.58	624.49	13,326.93	13,833.05	....	506.12
28—Raw Material Inspection	14.40	16.49	378.07	381.81	....	3.74
29—Plain Steel Receiving...	20.95	26.36	547.35	658.09	....	110.74
31—General Factory	151.95	133.47	3,629.14	3,166.39	462.75	.....
38—Shipping	168.84	229.59	3,868.49	4,835.34	....	966.85
Totals	1,607.72	1,801.19	37,181.79	39,301.00	....	2,119.21

(These figures are not actual, but illustrative only)

As will be indicated later, all these actual labor costs, standard labor costs, excess costs, and credits, are "tied in" with the general books so that they are reflected on the monthly burden statements and accumulated throughout the year (see Exhibit 4).

It should be stated here that our company has never enforced these controls in any ruthless manner. We do not regard labor as a commodity. We pay liberal bonuses annually, which are in reality a form of profit sharing. No piece-work rate is ever cut, unless there is a *complete* change in the process of manufacturing.

The effectiveness of these reports is established by the fact that the total cost per ton of tubing shipped for all of the process and overhead labor covered by these daily labor reports has been reduced to the extent of $8.78 per ton from 1935 to 1936, a net reduction of 15.5 per cent in our labor cost per ton produced.

4. The Measurement and Control of Manufacturing Burden

We have divided our plant into accounting divisions which we term "departments" or "burden centers," and all employees working in these departments are assigned numbers which associate them with their departments. In nearly every case the departments are supervised by separate foremen so that the management control and the accounting divisions are coextensive. But what is most important is that these divisions have been made primarily in order to segregate the economic elements of production costs. For example, departments #10 and #11, tube forming and tube welding respectively, are situated in tandem, operate in a synchronized manner, and might be considered a single processing unit but for one factor, the special annealing which is done in department #11 only. In order to know the cost of annealing it is necessary to have two departments.

All burden elements fall into two definite classes; namely, fixed and uncontrollable burden, and variable or controllable burden. The former includes: (1) depreciation, (2) taxes, (3) insurance, and (4) all salaries of manufacturing employees. Variable burden includes all process and indirect labor, repair and maintenance materials and labor, and processing supplies and charges, such as electricity, gas, water, tools, oils, etc. All such expenses as oils and fluxes, arbors, rollers, drawing dies, punches, etc., are charged to the burden accounts as variable burden rather than as direct cost factors because innumerable checks have established the fact that the standard hourly production rates and the departmental burden rates are so arranged that these cost elements are loaded against the various sizes and gauges of tubes in logical sequence.

In contrast to the conventional plan of employing only standard burden rates based on normal capacity and the more recent refinement of supplementing these rates with standard allowances for different levels of production, we have developed a complete system of *burden standards* for controlling all of the three main elements of variable burden; namely, labor, repairs and maintenance, and processing supplies. The labor standards have been described above. When operations are performed according to standard conditions the actual and standard labor figures will substantially coincide, and any variations can be detected through the daily flexible labor sheets. The other two elements of the variable burden—repairs and supplies—are budgeted by means of monthly burden standards shown on the burden statement, Exhibit 5.

An inspection of this report will show that a departmental burden or cost rate for a machine processing department is composed of the following:

1. Labor
2. Repairs and maintenance
3. Processing supplies
4. Fixed charges
5. General factory service charges, apportioned monthly.

Of these five elements the first three are directly variable and may be calculated by dividing the annual costs by the annual machine hours which produced those costs.

To this variable rate must be added a second rate to absorb the fixed charges of the department itself and a third rate to absorb the apportioned fixed and variable burden. Our conception of the development of a standard burden rate is, therefore, the following formula:

$$\text{Department burden rate} = \frac{\text{Annual Variable Burden (actual)}}{\text{Annual Variable Machine Hours (actual)}} + \frac{\text{Annual Fixed Charges}}{\text{Normal Annual Machine Hours}} + \frac{\text{Normal Annual Apportioned Burden}}{\text{Normal Annual Machine Hours}}$$

Our reason for developing this method is that we believe any attempt to determine a standard burden rate for a plant as a whole is as futile as attempting to make the fifty-two cards in a deck rotate in the same sequence after dealing. What we need first in analyzing burden is a division of the plant into the proper

EXHIBIT 5

MONTHLY BURDEN STATEMENT

Tube Tinning Department—No. 14

October, 1936

Account No.	Description	Current Month: Actual	Standard	Over	Under	Year to Date: Actual	Standard	Over	Under
	Labor								
1402	Setup	$ 45.20	$ 40.97	$ 4.23	.....	$ 375.22	$ 389.12	.....	$ 13.90
1403	Operating	975.37	985.47	.....	$ 10.10	10,419.76	11,005.72	.....	585.96
1404	Idle Time	.....	.....	.....	.....	.....	.....	.....	.....
1408	Servicing	4.96	9.20	.....	4.24	51.36	49.10	$ 2.26	.....
1420	Miscellaneous	3.22	6.54	.....	3.32	37.19	22.64	14.55	.....
	Total	$1,028.75	$1,042.18	.....	$ 13.43	$10,883.53	$11,466.58	.....	$ 583.05
	Repairs								
1421	Tinning Machines	$ 47.60	$ 85.22	.....	$ 37.62	$ 501.37	$ 504.10	.....	$ 2.73
1422	Swaging Machines	2.13	10.14	.....	8.01	27.12	31.67	.....	4.55
1440	Miscellaneous	67.36	70.19	.....	2.83	701.13	752.17	.....	51.04
	Total	$ 117.09	$ 165.55	.....	$ 48.46	$ 1,229.62	$ 1,287.94	.....	$ 58.32
	Supplies								
1441	Electricity	$ 20.05	$ 18.14	$ 1.91	.....	$ 251.13	$ 298.14	.....	$ 47.01
1442	Gas	53.73	65.12	.....	11.39	491.64	501.17	.....	9.53
1445	Solder	1,927.64	2,214.70	.....	287.06	20,417.36	24,375.16	.....	3,957.80
	Total	$2,001.42	$2,297.96	.....	$296.54	$21,160.13	$25,174.47	.....	$4,014.34
	TOTAL VARIABLE BURDEN	$3,147.26	$3,505.69	.....	$358.43	$33,273.28	$37,928.99	.....	$4,655.71
	Fixed Charges								
1461	Depreciation	$ 54.27	$ 54.27	.....	.....	$ 551.10	$ 551.10	.....	.....
1462	Taxes	10.36	10.36	.....	.....	108.74	108.74	.....	.....
1463	Insurance	2.96	2.96	.....	.....	22.16	22.16	.....	.....
1464	Salaries	85.22	85.22	.....	.....	795.13	795.13	.....	.....
	Total Fixed	$ 152.81	$ 152.81	.....	.....	$ 1,477.13	$ 1,477.13	.....	.....
1489	General Factory	$1,019.76	$1,002.10	$17.66	.....	$10,526.71	$ 9,412.16	$1,114.55	.....
	TOTAL BURDEN	4,319.83	4,660.60	.....	340.77	45,277.12	48,818.28	.....	$3,541.16
	Credits	5,210.64	5,210.64	.....	.....	50,417.38	50,417.38	.....	.....
	Balances ..... Cr.	$ 890.81	$ 550.04	.....	$340.77	$ 5,140.26	$ 1,599.10	.....	$3,541.16

(These figures are not actual, but illustrative only)

centers and the determination of separate and distinct rates. In other words, the problem should be developed inductively from departmental rates to a plant summary rather than deductively from some arbitrary conception of normal capacity based on sales volume. There can be no plant burden rate other than a composite summary of individual rates.

EXHIBIT 6

SUMMARY OF MANUFACTURING BURDEN BY ELEMENTS

November, 1936

	Burden			
	Actual	Standard	Over	Under
FIXED AND UNCONTROLLABLE BURDEN				
Salaries of Factory Employees	$ 10,512.63	$ 10,512.63		
Fixed Charges				
Depreciation	5,175.32	5,175.32		
Taxes	1,079.36	1,079.36		
Insurance	247.92	247.92		
Total Fixed Charges	$ 6,502.60	$ 6,502.60		
Total Fixed and Uncontrollable Burden	$ 17,015.23	$ 17,015.23		
VARIABLE BURDEN				
Indirect and Process Labor	$ 36,428.48	$ 35,971.62	$ 456.86	.....
Repairs	10,291.37	9,376.11	915.26	.....
Electricity	7,110.65	7,522.19	.....	$ 411.54
Gas	2,001.75	2,514.21	.....	512.46
Acids and Flux	1,736.95	1,622.97	113.98	.....
Oils	927.38	1,133.47	.....	206.09
Tools	10,569.37	9,122.17	1,447.20	.....
Solder	9,437.61	12,316.71	.....	2,879.10
Coal	1,050.27	1,122.69	.....	72.42
Miscellaneous	18,917.22	21,237.64	.....	2,320.42
Total Variable Burden	$ 98,471.05	$101,939.78	.....	$3,468.73
Gross Manfacturing Burden	$115,486.28	$118,955.01	.....	$3,468.73

(These figures are not actual, but illustrative only)

This fact is illustrated by our monthly summary of burden by elements, Exhibit 6. This enables us to ascertain what variable elements of burden are out of line with the standards. That such detailed standardization is not academic or theoretical is attested by the fact that for the first ten months of 1936 the variable and standard manufacturing expenses of our plant were within .1% (1/10th of 1%) of actual agreement. Without the use of these standards it would be impossible to determine exactly what the burden should have been at a sub-normal or super-normal level of production.

To summarize, the individual department statements and the summaries by elements and by departments give us the following valuable information:

1. The monthly and yearly accumulative *actual* burden rates.
2. The monthly and yearly accumulative burden standard allowances or what the burden should have been for the value produced.
3. The monthly and yearly accumulative burden balances, being the difference between the actual burden and the burden charged at the standard burden rates into work in process.
4. The monthly and yearly accumulative burden variances in detail by all variable burden accounts.

5. *The Control of Prices and Profits*

In this concluding section I shall attempt to explain how we utilize these various rates and standards for the scientific determination of prices and profits. A detailed estimate card is the basis of all such calculation, and one of these cards is completely filled out for every job that is quoted upon and for every price that is made.

In the first place, all sizes of tubes in storage on racks are carried at standard cost figures based upon the following:

1. Standard material costs.
2. Standard percentages for scrap and spoilage.
3. Standard hourly production rates.
4. Standard processing cost or burden rates.

When it becomes necessary to calculate a new estimate the sequence of figuring becomes the reverse of the one used for a profit and loss statement; namely:

1. Standard tube cost per C pieces.
2. Sawing labor and burden per C pieces.
3. Burring labor and burden per C pieces.
4. Fabrication labor and burden per C pieces.
5. Total manufacturing cost (sum of 1, 2, 3, and 4).
6. Administrative and selling burden (a fixed percentage of 5).
7. Charge for tools and fixtures.
8. Total final or selling cost (total of 5, 6, and 7).
9. Estimated or predetermined profit (percentage of 8).
10. Sales price quoted.

Since all of our product is sold without varying commissions or sales expenses, we employ a single standard rate to be added to the estimated manufacturing cost to cover selling and administrative burden. The resulting estimated or predetermined selling cost is thus predicated upon the attainment of certain definite performances with respect to production efficiency, material utilization, and volume of sales.

Because of the fact that all automobile models are changed annually, practically all tubing sub-assemblies are likewise changed. This, obviously, makes the application of a standard cost accounting procedure to the costing of these unlike parts somewhat more difficult than for the tube processing costs. To meet this difficulty we accumulate our cost of sales in two totals. The first represents the estimated or predetermined cost of all parts shipped, the manufacturing cost figures being taken from the estimate cards which were used when the quotations were made and the orders accepted. The second total represents the *actual* costs, or, to be exact, the actual quantities of tubes made at the standard tubing costs, plus the *actual* labor and burden expended in fabrication. The difference is reflected as a fourth variance account to be added to or deducted from the standard cost of sales.

The benefits of this procedure are twofold. In the first place, it provides a check on the accuracy of our estimating; and in the second place, it enables us to detect those jobs which bring difficulty in manufacturing. If a machine setup is so changed as to reduce the manufacturing time, the result becomes a credit to this variance account, bringing a lower cost than was anticipated and a proportionately larger profit. There is no disturbance to the true cost of sales as the variance accounts bring the net figures to an actual rather than a standard basis.

As we have two very different processes or classes of tubing our profit and loss statement is based upon a classification of sales into the following divisions:

1. Sweated tubing
2. Bundyweld tubing in straight lengths
3. Bundyweld tubing (fabricated)
4. Miscellaneous sales.

In the compilation of these statements the gross sales, return and allowance accounts, and cost of sales accounts are easily seg-

regated by classes. The apportionment of the balances for the departmental burden centers to these sales classes is done by a process of prorating on the basis of the standard cost of sales. For example, the balance, debit or credit, in department #17, bundyweld fabrication, is added to or deducted from the standard cost of sales of fabricated tubing only, but the balances in the saw and burring departments, #15 and #16, respectively, are apportioned to the cost of sales of bundyweld straight length sales and bundyweld fabricated sales. By this process and the apportionment of the sales and administrative burden in a similar manner, we arrive at a final profit or loss by a class or product classification.

Important and Unique Features

It might clarify this discussion if I should enumerate those features of our system which seem to me to be important and, to some extent, unique. Perhaps the most fundamental is the plan of departmentalization. We have endeavored to subdivide our business into accounting divisions which coincide with the production and personnel divisions. Secondly, we have emphasized daily rather than monthly control by giving each foreman daily reports of three essentials; viz., his efficiency in production, his control of labor, and his economy in the use of materials. We have also endeavored to eliminate errors and misunderstanding by insisting that production records must be identical with cost records, that estimating rates and procedure should coincide with cost accounting rates and procedure, and that daily reports should fit into and constitute the detail for all monthly reports. We have endeavored to use simple condensed figures for departmental results so that "he who runs may read," and understand. We have incorporated standards throughout—scrap standards, production standards, labor standards, burden standards, standard burden rates, and standard costs for our various sizes and gauges of tubing. Finally, we have employed variance accounts as a special device to be used in connection with a standard cost of sales. We not only believe that variance accounts are as logical a development in accounting as control accounts or clearing accounts, but we also believe that they are indispensable in reflecting the trend of the performances in the various important divisions of our business.

Why Standard Cost Accounting?

As all this represents the various aspects of a standard cost accounting plan, and as some accountants are opposed to standard costs, I shall endeavor to outline why I believe standard cost accounting or rather accounting with the aid of standards is here to stay. It must be obvious that the relationship of constants and variables can be determined with much simpler computations and with more accurate results than the relationship of one set of variables with another group of variables. If there is a sudden decline in the net profit of a company operating under an actual cost system it is impossible to determine whether the shrinkage is due to a reduction of volume, a reduction of prices, or a sudden increase of production costs. If, however, the cost of sales figure is built up on the basis of the standard quantities at the standard material prices, the standard labor hours at the standard labor cost, and the standard burden factors at the standard burden rates, and if, furthermore, the deviations from these costs are shown as separate variance accounts the responsibility for the sudden change can quickly be assigned, first to the manufacturing or the sales divisions, and if due to manufacturing, to that department, process, or cost element which is primarily responsible. Standard cost accounting, therefore, involves a simpler technique than actual cost acounting because of the greater frequency of variable factors in the latter.

A second argument for the use of standards in cost work is that scientists in all other fields have found it necessary to employ such standards for the facilitation of their computations. In addition to the horsepower, the watt, the volt, and the B.T.U., there have been adopted in recent years the light year for the measurement of astronomical distances, the decibel for the measurement of the intensity of sound, and the kilocycle meter for the measurement and control of radio broadcasting.

The essence of this discussion, therefore, is that in the development of an effective plan of industrial control, it is essential that the conventional balance sheet acounting at one end of a business and the varied mechanical processes at the other end should be coordinated by the use of rudimentary statistical science. The problem of the measurement and control of industrial facts is not es-

sentially different from the problem of measuring and controlling any other great group of facts. In the field of education we have observed in recent years the development, through mathematical methods, of mental measurements and the adoption, rather generally, of such methods as the Binet tests and the intelligence quotient. In the realm of the social sciences we have observed the brilliant accomplishments of Karl Pearson of the University of London, who, by means of his coefficient of correlation, has proven conclusively that there is no appreciable relationship between the size and shape of the human skull and an individual's intelligence. The final test of the truth or falsity of any opinion is usually a mathematical test. The following statement by Lord Kelvin aptly expresses this thought and may serve as a fitting conclusion to this discussion:

> "When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

BIBLIOGRAPHY

STANDARD COSTS IN SPECIFIC INDUSTRIES

N. A. C. A. Publications:

A Cost Plan for the Knitting Industry. C. W. Bennett. Sec. I, October 1, 1936.

Application and Uses of Standard Costs in the Shoe Industry. H. S. Wonson. Sec. I, November 1, 1936.

Application of Standard Cost to Railroad Administration. Charles C. James. Sec. I, September 1, 1936.

Basic Standard Costs as Applied to a Hosiery Mill. Lloyd F. Mogel. Sec. I, May 1, 1935.

Brief Summary of the Results Obtained Through Use of Standard Costs by the International Silver Company, A. William F. Worrall. 1928 Year Book.

Budgetary Control and Standard Costs in the Newsprint Paper Industry. George A. Ware. Sec. I, November 15, 1927.

Budgets and Standard Costs at Noe Equl Textile Mills, Inc. Lloyd F. Mogel. 1928 Year Book.

Cost Plan for the Women's Shoe Industry, A. Clinton W. Bennett. Sec. I, February 15, 1935.

Costs and Their Relation to General Accounting. Walter A. Musgrave. Sec. I, April 2, 1923. (Out of print.)

Developing Costs at a Brush Factory. William C. Fitts. Sec. I, January 1, 1935.

Experience of the American Chain Company with Standard Costs. W. C. Ettershank. 1928 Year Book.

Experience of the J. C. Haartz Company with Standard Costs. H. P. Hitchcock. 1928 Year Book.

Experience of the Stevens and Thompson Paper Company with Standard Costs. Henry R. Boston. 1928 Year Book.

Experience with Standard Costs in the Manufacture of Textiles. H. E. Parkman. 1928 Year Book.

Predetermined Costs in the Brewing Industry. Charles Weissinger. Sec. I, August 1, 1933.

Setting Standard Costs in a Metal-Working Plant. George N. Benoit. Sec. I, December 1, 1935. (Out of print.)

Setting Standards for Plating and Japanning Costs in a Job-Order Industry. Rudolph H. Redmond. Sec. I, March 1, 1934.

Standard Costs as Applied to Dress Manufacture. R. H. Rositzke. Sec. I, May 15, 1932.

Standard Costs for Machine Shops and Malleable Foundries. R. M. Sabin. Sec. I, December 1, 1933.

Standard Costs in Dyeing and Printing of Cotton Fabrics. Lewis F. Sawyer. Sec. I, June 1, 1933.

Standard Costs in the Illuminating and Industrial Glass Industry. G. A. Rothrauff. Sec. I, January 1, 1930.